U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-259 163

LAKE WILLIAM C. BOWEN, SPARTANBURG COUNTY, SOUTH CAROLINA

Corvallis Environmental Research Laboratory,
Oregon

May 1976

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Report on Lake William C. Bowen, Spartanburg County South Carolina		5. REPORT DATE Prepared May 1976 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anonymous (National Eutrophication Survey Staff)		8. PERFORMING ORGANIZATION REPORT NO. Working Paper # 429
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Eutrophication Survey U.S. Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Research and Development U.S. Environmental Protection Agency 401 M Street, S. W. Washington, DC 20460		13. TYPE OF REPORT AND PERIOD COVERED Final - 1973 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C

PRICES SUBJECT TO CHANGE

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
Release unlimited		39
	20. SECURITY CLASS (This page)	22. PRICE $4.00/3.00

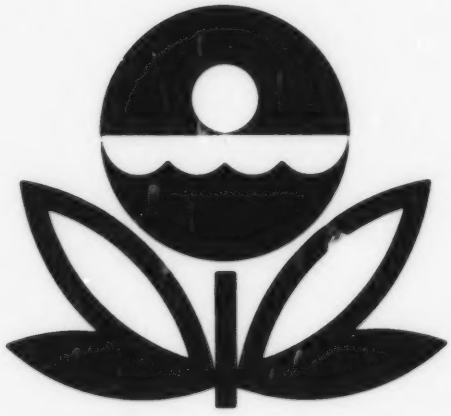
EPA Form 2220-1 (9-73)

309154

PB 259 163

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES



CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

O. 699-440

REPORT

ON

LAKE WILLIAM C. BOWEN

SPARTANBURG COUNTY

SOUTH CAROLINA

EPA REGION IV

WORKING PAPER No. 429

WITH THE COOPERATION OF THE

SOUTH CAROLINA DEPARTMENT OF HEALTH AND

ENVIRONMENTAL CONTROL

AND THE

SOUTH CAROLINA NATIONAL GUARD

MAY, 1976

CONTENTS

	Page
Foreword	ii
List of South Carolina Study Lakes	iv
Lake and Drainage Area Map	v
Sections	
I. Conclusions	1
II. Lake and Drainage Basin Characteristics	3
III. Lake Water Quality Summary	4
IV. Nutrient Loadings	8
V. Literature Reviewed	12
VI. Appendices	13

F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the South Carolina Department of Health and Environmental Control for professional involvement, to the South Carolina National Guard for conducting the tributary sampling phase of the Survey, and to those South Carolina wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

The staff of the South Carolina Bureau of Wastewater and Stream Quality Control provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

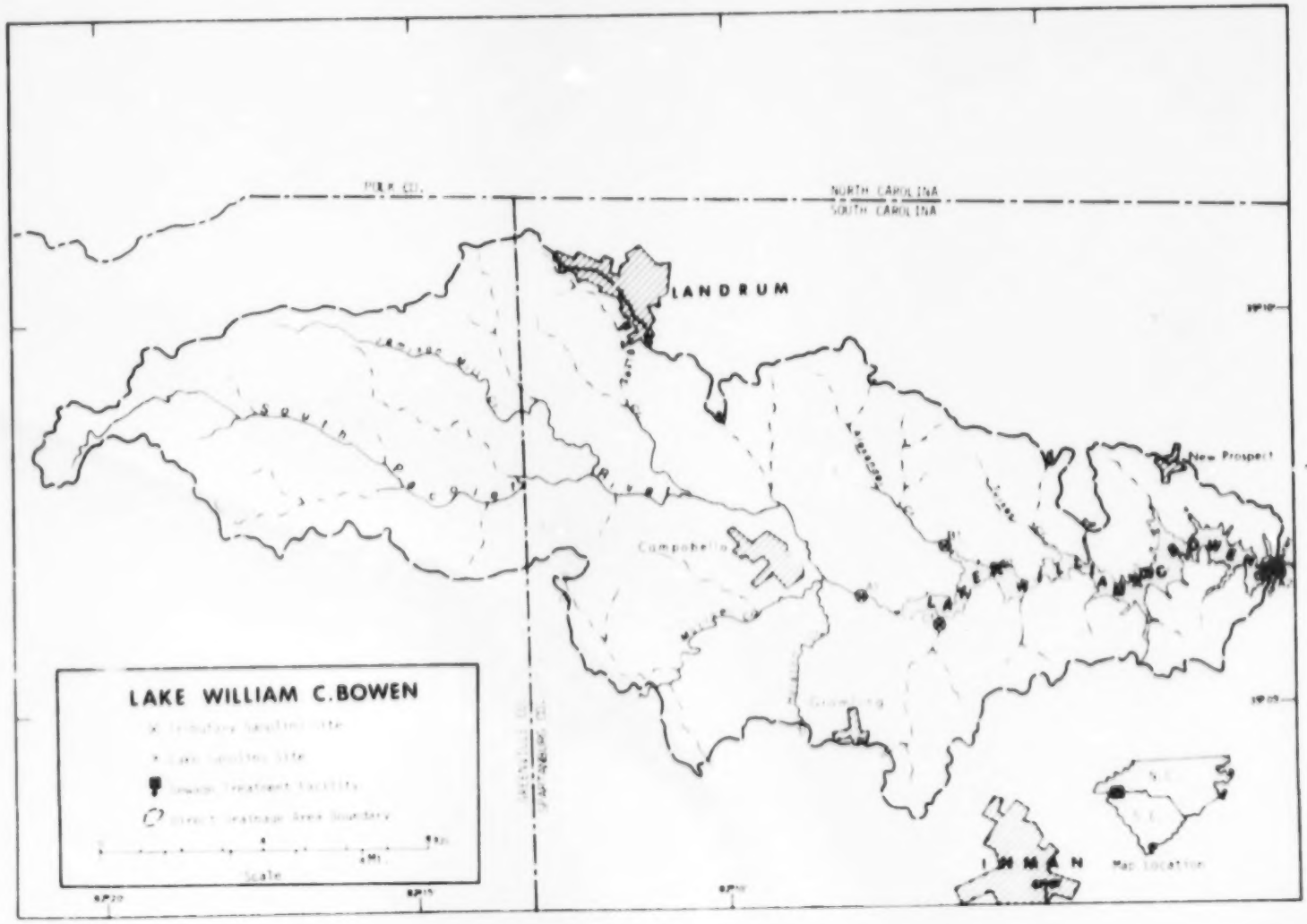
Major General Robert L. McCrady, the Adjutant General of South Carolina, and Project Officer Lt. Colonel John P. DuPre (Retired), who directed the volunteer efforts of the South Carolina National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF SOUTH CAROLINA

NAME	COUNTY
Clark Hill	Abbeville, McCormick, SC; Columbia, Elbert, Lincoln, McDuffie, Wilks, GA
Fishing Creek	Chester, Lancaster
Greenwood	Greenwood, Laurens, Newberry
Hartwell	Anderson, Oconee, Pickens, SC; Franklin, Hart, Stephens, GA
Keowee	Oconee, Pickens
Marion	Berkeley, Calhoun, Claredon, Orangeburg, Sumter
Moultrie	Berkeley
Murray	Lexington, Newberry, Richland, Saluda
Robinson	Chesterfield, Darlington
Saluda	Greenville, Pickens
Secession	Abbeville, Anderson
Wateree	Fairfield, Kershaw, Lancaster
William C. Bowen	Spartanburg
Wylie	York, SC; Gaston, Mecklenburg, NC


NORTH CAROLINA
SOUTH CAROLINA
LANDRUM
New Prospect
Campobello
LAKE WILLIAM C.BOWEN
Scale
Map Location

LAKE WILLIAM C. BOWEN

STORET NO. 4516

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Lake William C. Bowen is meso-eutrophic. It ranked seventh in overall trophic quality when the 13 South Carolina lakes sampled in 1973 were compared using a combination of six parameters*. Three of the lakes had less median total phosphorus, six had less and one had the same median dissolved phosphorus, nine had less median inorganic nitrogen, three had less mean chlorophyll a, and five had greater mean Secchi disc transparency.

No nuisance conditions were noted by Survey limnologists; however, some emergent vegetation was observed in the shallow areas near sampling station one, and oxygen depression or depletion occurred at station three.

B. Rate-Limiting Nutrient:

The algal assay results show phosphorus limitation at the time the sample was collected (03/29/73). The lake data indicate phosphorus limitation at all sampling times.

C. Nutrient Controllability:

1. Point sources--The phosphorus contribution of the Landrum wastewater treatment plant accounted for 9.7% of the total load reaching the lake.

* See Appendix A.

During the sampling year, the lake received a total phosphorus loading only slightly more than that proposed by Vollenweider (Vollenweider and Dillon, 1974) as an oligotrophic loading (see page 11). However, the hydraulic retention time of the lake is not known, and it is possible that Vollenweider's model is not applicable. Also, the apparent loss of phosphorus from the lake during the year while over 20% of the nitrogen was retained (pages 9 and 10), indicates an underestimation of phosphorus inputs or phosphorus sources discharging directly to the lake or to unsampled tributaries.

While a phosphorus wash-out could have occurred if inputs had been recently reduced, there is no indication that such a reduction occurred, and a need for further study of the phosphorus balance of the lake is indicated.

2. Non-point sources--Although the sampled tributaries accounted for over 76% of the total load, the phosphorus export rates were quite low during the sampling year (page 10).

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 6.48 kilometers^2.
2. Mean depth: Unknown.
3. Maximum depth: 12.5 meters.
4. Volume: Unknown.
5. Mean hydraulic retention time: Unknown.

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
S. Pacolet River	145.0	2.45
Alexander Creek	13.9	0.15
Unnamed Creek C-1	10.0	0.10
Minor tributaries & immediate drainage -	37.2	0.46
Totals	206.1	3.16

2. Outlet -

S. Pacolet River	212.6**	3.16

C. Precipitation***:

1. Year of sampling: 160.0 centimeters.
2. Mean annual: 127.7 centimeters.

---

† Table of metric conversions--Appendix B.
†† Mast, 1974.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Lake William C. Bowen was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at three stations on the lake (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 2.1 meters at station 1, 7.0 meters at station 2, and 10.7 meters at station 3.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR LAKE WILLIAM C. BOWEN
STORET CODE 4516

	1ST SAMPLING (3/29/73) 3 SITES			2ND SAMPLING (7/11/73) 3 SITES			3RD SAMPLING (9/20/73) 3 SITES		
PARAMETER	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN
TEMP (C)	9.0 - 13.9	12.8	13.3	13.4 - 30.4	25.0	28.9	12.7 - 25.1	22.3	24.1
DISS OXY (MG/L)	8.7 - 9.8	9.2	9.3	0.8 - 8.4	4.3	1.8	0.0 - 8.2	4.1	5.4
CNDCTVY (MCROMO)	50. - 50.	50.	50.	50. - 50.	50.	50.	34. - 82.	45.	35.
PH (STAND UNITS)	7.4 - 8.0	7.7	7.7	6.0 - 7.7	6.8	7.0	6.2 - 7.5	6.7	6.6
TOT ALK (MG/L)	10. - 20.	14.	14.	10. - 22.	15.	15.	10. - 26.	15.	15.
TOT P (MG/L)	0.027 - 0.077	0.046	0.048	0.013 - 0.037	0.022	0.022	0.006 - 0.018	0.012	0.013
ORTHO P (MG/L)	0.003 - 0.007	0.005	0.004	0.005 - 0.032	0.013	0.010	0.006 - 0.012	0.008	0.008
NO2+NO3 (MG/L)	0.290 - 0.340	0.311	0.310	0.090 - 0.390	0.162	0.120	0.020 - 0.040	0.027	0.020
AMMONIA (MG/L)	0.050 - 0.080	0.070	0.070	0.090 - 0.520	0.180	0.110	0.040 - 0.780	0.247	0.065
KJEL N (MG/L)	0.200 - 0.400	0.268	0.200	0.200 - 0.980	0.450	0.400	0.200 - 1.000	0.610	0.600
INORG N (MG/L)	0.350 - 0.420	0.381	0.380	0.190 - 0.610	0.342	0.250	0.060 - 0.720	0.274	0.095
TOTAL N (MG/L)	0.500 - 0.740	0.571	0.520	0.420 - 1.000	0.612	0.580	0.240 - 1.020	0.637	0.630
CHLRPYL A (UG/L)	2.0 - 5.3	3.8	4.2	1.3 - 3.8	2.2	1.4	5.3 - 6.2	5.7	5.7
SECCHI (METERS)	0.3 - 0.6	0.4	0.5	1.0 - 1.4	1.1	1.0	1.0 - 1.7	1.5	1.7

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera		Algal Units per ml
03/29/73	1. *Cryptomonas sp.*		223
	2. *Melosira sp.*		81
	3. *Mougeotia sp.*		81
	4. *Asterionella sp.*		20
		Total	405
07/11/73	1. *Cyclotella sp.*		1,383
	2. *Melosira sp.*		829
	3. *Merismopedia sp.*		275
	4. Flagellates		138
	5. *Gloeothece sp.*		115
	Other genera		279
		Total	3,019
09/20/73	1. *Melosira sp.*		592
	2. *Cyclotella sp.*		464
	3. *Gloeothece sp.*		186
	4. *Merismopedia sp.*		93
	5. *Gomphosphaerium sp.*		58
	Other genera		173
		Total	1,566

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
03/29/73	1	4.2
	2	5.3
	3	2.0
07/11/73	1	3.8
	2	1.4
	3	1.3
09/20/73	1	5.7
	2	6.2
	3	5.3

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.005	0.287	0.1
0.010 P	0.015	0.287	2.3
0.020 P	0.025	0.287	6.0
0.050 P	0.055	0.287	7.5
0.025 P + 0.5 N	0.030	0.787	9.5
0.050 P + 1.0 N	0.055	1.287	23.5
1.0 N	0.005	1.287	0.1

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of the lake was low at the time the sample was collected (03/29/73). The increase in yield with increased levels of phosphorus, as well as the lack of increase when only nitrogen was added, indicates phosphorus limitation.

The lake data also indicate phosphorus limitation; i.e., the mean inorganic nitrogen/orthophosphorus ratios were 26/1 or greater at all sampling times, and phosphorus limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the South Carolina National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff month of January when two samples were collected. Sampling was begun in February, 1973, and was completed in February, 1974.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the South Carolina District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads shown are those measured minus point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads at stations B-1 and C-1, in $kg/km^2/year$, and multiplying the means by the ZZ area in km^2.

The operator of the Landrum wastewater treatment plant provided monthly effluent samples and corresponding flow data.

* See Working Paper No. 175.

A. Waste Sources:

1. Known municipal* -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Landrum	400	stab. pond	79.5	Spivey Creek

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (non-point load) -		
S. Pacolet River	1,780	70.4
Alexander Creek	95	3.7
Unnamed Creek C-1	60	2.4
b. Minor tributaries & immediate drainage (non-point load) -	240	9.5
c. Known municipal STP's -		
Landrum	245	9.7
d. Septic tanks - Unknown	-	-
e. Known industrial - None	-	-
f. Direct precipitation** -	110	4.3
Total	2,530	100.0

2. Outputs -

Lake outlet - S. Pacolet River 2,580

3. Net annual P loss - 50 kg.

---

* Ayres, 1974.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
S. Pacolet River	60,985	76.0
Alexander Creek	2,485	3.1
Unnamed Creek C-1	2,195	2.7
b. Minor tributaries & immediate drainage (non-point load) -	7,420	9.3
c. Known municipal STP's -		
Landrum	310	0.4
d. Septic tanks - Unknown	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	6,855	8.5
Total	80,250	100.0

2. Outputs -

Lake outlet - S. Pacolet River 63,910

3. Net annual N accumulation - 16,340 kg.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	kg $P/km^2/yr$	kg $N/km^2/yr$
S. Pacolet River	12	421
Alexander Creek	7	179
Unnamed Creek C-1	6	220

* See Working Paper No. 175.

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.39	loss	12.4	2.5

Vollenweider phosphorus loadings ($g/m^2/yr$) based on area and mean outflow of Lake William C. Bowen:	
"Dangerous" (eutrophic loading)	0.76
"Permissible" (oligotrophic loading)	0.38

V. LITERATURE REVIEWED

Ayres, C. J., 1974. Personal communication (wastewater treatment plant information). City of Landrum.

Mast, G. Nelson, 1974. Personal communication (lake morphometry). SC Dept. of Health & Env. Contr., Columbia.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	SOO-MEAN SEC	MEAN CHLORA	1S-MIN O	MEDIAN DISS ORTHO P
4503	FISHING CREEK RESERVOIR	0.143	0.535	483.000	2.411	10.200	0.051
4504	LAKE GREENWOOD	0.061	0.470	463.917	8.150	15.000	0.011
4505	LAKE HARTWELL	0.013	0.130	422.000	6.157	15.000	0.004
4506	LAKE MARION	0.055	0.280	470.176	8.728	14.900	0.010
4507	LAKE MURRAY	0.024	0.260	424.905	6.478	15.000	0.007
4508	LAKE ROBINSON	0.014	0.260	458.778	8.611	14.000	0.005
4510	LAKE WATEREE	0.094	0.450	475.667	8.408	14.100	0.034
4511	LAKE WYLIE	0.045	0.380	462.222	5.423	14.800	0.013
4512	LAKE MOULTRIE	0.025	0.200	455.36	8.800	11.200	0.006
4513	LAKE KEOWEE	0.008	0.170	371.750	2.433	15.000	0.003
4514	LAKE SECESSION	0.057	0.355	462.778	10.722	15.000	0.006
4515	SALUDA LAKE	0.046	0.230	476.833	1.517	10.800	0.006
4516	LAKE WILLIAM C. HOWEN	0.022	0.360	459.889	3.911	15.000	0.007

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN SD	MEDIAN DISS ORTHO P	INDEX NO
4503	FISHING CREEK RESERVOIR	0 (0)	0 (0)	0 (0)	92 (11)	100 (12)	0 (0)	192
4504	LAKE GREENWOOD	17 (2)	8 (1)	33 (4)	42 (5)	21 (0)	25 (3)	146
4505	LAKE HARTWELL	92 (11)	100 (12)	92 (11)	58 (7)	21 (0)	92 (11)	455
4506	LAKE MARION	33 (4)	50 (6)	25 (3)	17 (2)	50 (6)	33 (4)	208
4507	LAKE MURRAY	67 (8)	62 (7)	83 (10)	50 (6)	21 (0)	46 (5)	329
4508	LAKE ROBINSON	83 (10)	62 (7)	67 (8)	25 (3)	75 (9)	83 (10)	345
4510	LAKE WATEREE	8 (1)	17 (2)	17 (2)	33 (4)	67 (8)	8 (1)	150
4511	LAKE WYLIE	50 (6)	25 (3)	50 (6)	67 (8)	58 (7)	17 (2)	267
4512	LAKE MOULTRIE	58 (7)	83 (10)	75 (9)	8 (1)	83 (10)	71 (8)	378
4513	LAKE KEOWEE	100 (12)	92 (11)	100 (12)	83 (10)	21 (0)	100 (12)	496
4514	LAKE SECESSION	25 (3)	42 (5)	42 (5)	0 (0)	21 (0)	58 (7)	188
4515	SALUDA LAKE	42 (5)	75 (9)	8 (1)	100 (12)	92 (11)	71 (8)	388
4516	LAKE WILLIAM C. BOWEN	75 (9)	33 (4)	58 (7)	75 (9)	21 (0)	46 (5)	308

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4513	LAKE KEOWEE	496
2	4505	LAKE HARTWELL	455
3	4508	LAKE ROBINSON	395
4	4515	SALUDA LAKE	386
5	4512	LAKE MOULTRIE	374
6	4507	LAKE MURRAY	324
7	4516	LAKE WILLIAM C. BOWEN	308
8	4511	LAKE WYLIE	267
9	4506	LAKE MARION	208
10	4503	FISHING CREEK RESERVOIR	192
11	4514	LAKE SECESSION	188
12	4510	LAKE WATEREE	150
13	4504	LAKE GREENWOOD	146

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR SOUTH CAROLINA 04/27/76

LAKE COUE 4516 LAKE WILLIAM C HOWEN

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 212.6

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
4516A1	145.0	2.80	3.43	3.71	3.51	2.46	2.07	1.84	1.84	1.67	1.84	1.93	2.41	2.45
4516A2	212.6	3.41	4.58	4.31	3.58	3.20	2.79	2.44	2.63	2.25	2.66	2.98	3.25	3.16
4516M1	13.9	0.142	0.198	0.255	0.227	0.170	0.142	0.113	0.113	0.085	0.113	0.142	0.142	0.153
4516C1	10.0	0.113	0.142	0.142	0.142	0.113	0.085	0.057	0.057	0.057	0.085	0.085	0.113	0.099
4516ZZ	37.3	0.48	0.62	0.74	0.68	0.48	0.40	0.34	0.34	0.28	0.34	0.37	0.45	0.46

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 212.6
SUM OF SUB-DRAINAGE AREAS = 206.3
TOTAL FLOW IN = 38.06
TOTAL FLOW OUT = 38.07

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4516A1	2	73	5.069	11	2.832				
	3	73	5.239	4	3.002				
	4	73	4.927	16	3.483				
	5	73	3.964	4	2.549				
	6	73	3.653	3	2.860	28	3.171		
	7	73	2.379						
	8	73	1.897	5	1.897				
	9	73	2.407	8	1.274				
	10	73	1.671	7	1.586				
	11	73	1.586	10	1.416				
	12	73	2.690	2	1.671				
	1	74	4.134	6	3.483	20	2.379		
	2	74	3.794	3	5.862				
4516A2	2	73	7.362	11	4.474				
	3	73	7.023	4	3.568				
	4	73	7.362	16	5.182				
	5	73	5.522	4	4.474				
	6	73	5.380	3	4.701	28	2.973		
	7	73	3.341						
	8	73	3.851	5	3.794				
	9	73	3.115	8	1.586				
	10	73	4.021	7	4.021				
	11	73	2.520	10	3.964				
	12	73	1.416	2	1.586				
	1	74	5.437	6	5.862	20	4.248		
	2	74	5.380	3	5.295				

TRIBUTARY FLOW INFORMATION FOR SOUTH CAROLINA 04/27/76

LAKE CODE 4516 LAKE WILLIAM C BOWEN

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4516B1	2	73	0.481	11	0.283				
	3	73	0.510	4	0.283				
	4	73	0.481	16	0.340				
	5	73	0.368	4	0.255				
	6	73	0.340	3	0.283	28	0.311		
	7	73	0.227						
	8	73	0.170	5	0.170				
	9	73	0.227	8	0.113				
	10	73	0.170	7	0.142				
	11	73	0.142	10	0.142				
	12	73	0.255	2	0.170				
	1	74	0.396	6	0.340	20	0.227		
	2	74	0.368	3	0.566				
4516C1	2	73	0.340	11	0.198				
	3	73	0.368	4	0.198				
	4	73	0.340	8	0.255				
	5	73	0.283	4	0.170				
	6	73	0.255	3	0.198	28	0.227		
	7	73	0.170						
	8	73	0.142	5	0.142				
	9	73	0.170	8	0.085				
	10	73	0.113	7	0.113				
	11	73	0.113	10	0.085				
	12	73	0.198	2	0.113				
	1	74	0.283	6	0.255	20	0.170		
	2	74	0.255	3	0.396				
4516Z2	2	73	1.303	11	0.736				
	3	73	1.331	4	0.765				
	4	73	1.246	16	0.906				
	5	73	1.019	4	0.651				
	6	73	0.934	3	0.736	28	0.821		
	7	73	0.623						
	8	73	0.481	5	0.481				
	9	73	0.623	8	0.311				
	10	73	0.425	7	0.396				
	11	73	0.396	10	0.368				
	12	73	0.680	2	0.425				
	1	74	1.048	6	0.906	20	0.623		
	2	74	0.963	3	1.501				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/04/27

451601
35 06 36.0 082 05 32.0 3
LAKE WILLIAM C. BOWEN
45083 SOUTH CAROLINA

030891

11EPALES 2111202
0010 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/03/29	14 45	0000	13.9		11	50K	7.80	17	0.080	0.300	0.300	0.006
	14 45	0006	13.9	8.7		50K	7.70	17	0.060	0.400	0.290	0.004
73/07/11	10 15	0000	30.0		54	50K	7.60	16	0.120	0.900	0.100	0.011
	10 15	0004	29.7	8.0		50K	7.20	15	0.090	0.400	0.120	0.009
	10 15	0007	28.4	7.8		50K	6.80	15	0.100	0.300	0.160	0.005
73/09/20	10 15	0000	23.9	6.2	40	34	7.50	14	0.050	0.400	0.040	0.008
	10 15	0006	23.7	8.2		35	7.10	12	0.040	0.200	0.040	0.009

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/03/29	14 45	0000	0.077	4.2
	14 45	0006	0.070	
73/07/11	10 15	0000	0.024	3.8
	10 15	0004	0.018	
	10 15	0007	0.023	
73/09/20	10 15	0000	0.016	5.7
	10 15	0006	0.015	

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/04/27

451602
35 06 25.0 082 03 20.0 3
LAKE WILLIAM C. BOWEN
45083 SOUTH CAROLINA

030891

11EPALES 2111202
0018 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/03/29	15	0000	13.6		20	50K	7.80	18	0.080	0.400	0.340	0.007
	15	0004	13.6	9.3		50K	7.80	20	0.080	0.200	0.320	0.007
	15	0015	13.6	9.5		50K	7.70	20	0.070	0.200	0.320	0.005
73/07/11	10	0000	30.1		40	50K	7.70	13	0.090	0.600	0.100	0.005
	10	0005	29.9	7.8		50K	7.20	12	0.100	0.300	0.120	0.008
	10	0015	22.1	1.8		50K	6.20	15	0.360	0.600	0.230	0.008
	10	0023	18.8	0.8		50K	6.40	22	0.520	0.600	0.090	0.006
73/09/20	09	0000	24.9	7.4	68	34	6.90	13	0.040	0.400	0.020	0.006
	09	0010	24.8	0.8		34	6.70	26	0.670	0.700	0.040	0.007
	09	0020	21.8	4.6		82	6.60	16	0.080	0.500	0.020	0.010

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/03/29	15	0000	0.053	5.3
	15	0004	0.049	
	15	0015	0.048	
73/07/11	10	0000	0.017	1.4
	10	0005	0.013	
	10	0015	0.021	
	10	0023	0.037	
73/09/20	09	0000	0.010	6.2
	09	0010	0.014	
	09	0020	0.018	

A VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 76/04/27

451603
35 06 30.0 082 01 05.0 3
LAKE WILLIAM C. BOWEN
45083 SOUTH CAROLINA

030891

11EPALES 2111202
0038 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/03/29	15 35	0000	13.1		22	50K	7.40	10K	0.060	0.300	0.310	0.004
	15 35	0004	13.1	9.8		50K	8.00	10K	0.050	0.200K	0.300	0.004
	15 35	0015	12.5	9.0		50K	7.90	10K	0.070	0.200K	0.310	0.005
	15 35	0025	12.0	9.0		50K	7.70	10K	0.070	0.200K	0.300	0.003
	15 35	0034	9.0	9.3		50K	7.60	10K	0.080	0.200K	0.320	0.004
73/07/11	11 20	0000	30.4		40	50K	7.30	13	0.110	0.500	0.120	0.018
	11 20	0005	29.5	8.4		50K	7.20	11	0.110	0.300	0.130	0.018
	11 20	0015	21.4	1.6		50K	6.10	10	0.170	0.300	0.270	0.032
	11 20	0025	16.7	1.4		50K	6.00	14	0.100	0.200K	0.390	0.019
	11 20	0035	13.4	0.8		50K	6.20	19	0.290	0.400	0.120	0.021
73/09/20	09 20	0000	25.1	6.6	66	35	6.50	17	0.050	0.800	0.030	0.012
	09 20	0007	25.1	6.6		34	6.50	10	0.050	0.300	0.020	0.006
	09 20	0015	24.3	0.4		38	6.20	11	0.160	0.800	0.020	0.008
	09 20	0025	16.3	0.0		49	6.50	16	0.630	1.000	0.020	0.006
	09 20	0035	12.7	0.0		70	6.60	17	0.700	1.000	0.020	0.008

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/03/29	15 35	0000	0.027	2.0
	15 35	0004	0.031	
	15 35	0015	0.029	
	15 35	0025	0.027	
	15 35	0034	0.050	
73/07/11	11 20	0000	0.018	1.3
	11 20	0005	0.014	
	11 20	0015	0.035	
	11 20	0025	0.025	
	11 20	0035	0.023	
73/09/20	09 20	0000	0.013	5.3
	09 20	0007	0.011	
	09 20	0015	0.014	
	09 20	0025	0.006	
	09 20	0035	0.008	

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX E

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/04/27

4516A1
35 06 30.0 082 07 30.0 4
S PACOLET RIVER
45 SPARTANBURG CO H
1/LAKE WILLIAM C BOWEN 030891
BRDG ON SEONDARY RD 1 MI SE CAMPOBELLO
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/02/11	09 30		0.310	0.100K	0.036	0.007	0.020
73/03/04	09 35		0.280	0.100K	0.029	0.008	0.025
73/04/16	09 00		0.273	0.240	0.035	0.012	0.040
73/05/04	20 20		0.240	1.200	0.046	0.010	0.055
73/06/03	09 40		0.198	1.380	0.076	0.011	0.035
73/06/28	13 30		0.320	1.760	0.680	0.012	
73/08/05	09 40		0.273	0.150	0.027	0.011	0.030
73/09/08	09 00		0.020	0.390	0.084	0.005K	0.015
73/10/07	09 45		0.010K	0.860	0.115	0.005K	0.010
73/11/10	09 15		0.020	0.400	0.200	0.005K	0.005K
73/12/02	09 00		0.056	0.300	0.168	0.005K	0.025
74/01/06	09 00		0.168	0.600	0.140	0.008	0.055
74/01/20	13 40		0.350	0.400	0.040	0.005K	0.015
74/02/03	09 00		0.312	0.500	0.095	0.005	0.015

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/04/27

4516A2
35 06 30.0 082 01 30.0 4
S PACOLET RIVER
45 SPARTANBURG CO H
0/LAKE WILLIAM C BOWEN 030891
BROG ON RT 213 2.5 MI S OF FINGERVILLE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/02/11	08	45	0.250	0.130	0.046	0.009	0.030
73/03/04	08	50	0.260	0.230	0.039	0.015	0.030
73/04/16	09	30	0.160	0.340	0.078	0.015	0.045
73/05/04	19	30	0.240	1.200	0.066	0.019	0.045
73/06/03	10	10	0.220	0.420	0.140	0.005K	0.015
73/06/28	24	00	0.176	0.660	0.110	0.016	0.045
73/08/05	09	00	0.058	0.295	0.105	0.009	0.020
73/09/08	09	30	0.140	0.180	0.034	0.005K	0.025
73/10/07	10	15	0.010K	1.050	0.115	0.005K	0.010
73/11/10	08	45	0.028	0.400	0.208	0.005K	0.005K
73/12/02	09	30	0.056	0.300	0.176	0.005K	0.055
74/01/06	09	30	0.140	0.400	0.114		0.015
74/01/20	13	50	0.240	0.500	0.148	0.005K	0.015
74/02/03	09	30	0.336	0.700	0.110	0.005	0.015

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/04/27

4516H1
35 07 00.0 082 06 30.0 4
ALEXANDER CREEK
45 SPARTANBURG CO H
T/LAKE WILLIAM C BOWEN 030891
BRDG ON SEC HWY 3 MI E OF CAMPOBELLO
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/02/11	09	10	0.168	0.130	0.086	0.005K	0.010
73/03/04	09	15	0.140	0.200	0.040	0.005K	0.010
73/04/16	09	45	0.130	0.240	0.037	0.018	0.045
73/05/04	19	00	0.110	1.080	0.069	0.008	0.030
73/06/03	10	45	0.120	0.180	0.038	0.005K	0.025
73/06/28	13	15	0.138	0.300	0.067	0.005K	0.035
73/08/05	09	20	0.140	0.110	0.052	0.006	0.020
73/09/08	10	05	0.140	0.220	0.037	0.005K	0.015
73/10/07	10	45	0.010K	1.260	0.132	0.005K	0.015
73/11/10	09	30	0.020	0.450	0.216	0.005K	0.005K
73/12/02	10	00	0.056	0.300	0.176	0.005K	0.030
74/01/06	10	00	0.148	0.400	0.144	0.005K	0.020
74/01/20	13	30	0.176	0.100K	0.044	0.005K	0.005K
74/02/03	10	00	0.320	0.700	0.130	0.010	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/04/27

4516C1
35 06 00.0 082 06 30.0 4
UNNAMED CREEK
45 SPARTANBURG CO H
T/LAKE WILLIAM C BOWEN 030891
BRDG ON SECONDARY HWY 2 MI NE GRAMLING
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/02/11	09 45		0.450	0.105	0.105	0.005K	0.005K
73/03/04	10 00		0.410	0.130	0.058	0.005K	0.005K
73/04/08	10 15		0.300	0.240	0.048	0.020	0.060
73/05/04	20 00		0.350	0.940	0.069	0.008	0.030
73/06/03	11 25		0.189	1.150	0.250	0.009	0.033
73/06/28	13 45		0.350	0.960	0.189	0.005K	0.030
73/08/05	10 00		0.360	0.160	0.060	0.005K	0.010
73/09/08	10 45		0.147	0.660	0.054	0.005K	0.015
73/10/07	11 00		0.010K	0.690	0.110	0.005K	0.015
73/11/10	09 45		0.024	0.400	0.224	0.005K	0.005K
73/12/02	10 45		0.056	0.300	0.176	0.005K	0.030
74/01/06	10 30		0.156	0.400	0.135	0.005K	0.020
74/01/20	13 50		0.470	0.200	0.080	0.005K	0.005K
74/02/03	10 30		0.300	0.400	0.070	0.010	0.015

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/04/27

4516XA ST4516XA P000400
35 10 00.0 082 11 28.0 4
LANDRUM
45 SPARTANBURG CO
T/LAKE WM C BOWEN 030891
SPIVEY CREEK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/06/06	10 00		0.017	7.500	0.303	7.300	7.700		
73/08/01	10 00		0.100	11.500	0.710	6.650	8.900	0.027	0.024
73/09/10	10 00		0.019	15.400	3.020	10.300	12.050	0.008	0.028
73/10/04	14 00		0.040	18.000	4.900	11.600	12.500	0.008	0.008
73/11/14	11 30		0.070	17.500	5.500	12.600	14.500	0.010	0.011
74/01/16	10 45		0.040	2.300	1.600	6.650	8.100	0.021	0.021
74/02/05	09 00		0.200	9.000	1.240	6.300	7.700	0.024	0.020
74/03/04	10 00		0.200	9.900	0.170	5.400	7.675	0.025	0.025
74/04/15	11 00		0.080	10.000	2.900	4.700	6.400	0.020	0.025
74/05/06	14 10		0.160	14.000	4.600	6.000	7.330	0.019	0.023